

# PATENT SPECIFICATION

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(54) CRYSTALS OF LITHIUM SALTS HAVING EXCELLENT  
 STABILITY IN A NEUTRON FLUX

(71) We, COMMISSARIAT A  
 L'ENERGIE ATOMIQUE, an organisation  
 created in France by ordinance No. 45—  
 2563 of 18th October 1945, of 29 rue de la  
 Federation, Paris 15e, France, do hereby  
 declare the invention, for which we pray that  
 a patent may be granted to us, and the method  
 by which it is to be performed, to be particu-  
 larly described in and by the following state-  
 ment:—

This invention relates to piezoelectric  
 materials of use as transducers in a neutron  
 flux.

The piezoelectric materials according to the  
 invention are characterised in that they com-  
 prise crystals of lithium salts selected from  
 the group comprising lithium niobate and  
 lithium tantalate wherein the lithium has a  
 lithium 7 isotope content greater than that of  
 natural lithium.

According to one advantageous feature of  
 the invention, the lithium 7 isotope content  
 is greater than 99%.

Lithium tantalate ( $\text{LiTaO}_3$ ) and lithium  
 niobate ( $\text{LiNbO}_3$ ) are, of course, materials  
 with a wide range of applications not only in  
 low and average temperature areas, but also  
 in high-temperature applications, because they  
 have a number of properties not found in  
 combination in any other material (for example  
 ferro-electric, optical, piezoelectric elastic and  
 other properties).

More particularly, they have the following  
 properties:

1. A high electromechanical coupling co-  
 efficient. The electromechanical coupling co-  
 efficient, of course, is an indication of the  
 efficiency of conversion of mechanical energy  
 to electrical energy and vice-versa.

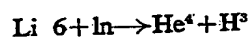
2. A very high maximum operating fre-  
 quency of the order of  $2 \cdot 10^9$  Hz, this high fre-  
 quency being the starting point in the develop-  
 ment of the delay lines used in telecommuni-  
 cations.

Lithium tantalate and lithium niobate have  
 good stability to  $\alpha$ ,  $\beta$  and  $\gamma$  radiation; they  
 also have a relatively good stability in a  
 neutron flux, but only when the instantaneous

and integrated flux, and the neutron energy  
 used, do not exceed a certain value.

The object of the invention is greatly to  
 improve the stability of these substances in a  
 neutron flux, more particularly when they are  
 used as piezoelectric materials in transducers,  
 deformation, swelling and final breakdown of  
 the lithium niobate or tantalate crystals being  
 avoided.

Up till now, the lithium used for the pro-  
 duction of crystals of lithium salts was natural  
 lithium, i.e. lithium formed from 7.4% of  
 Li 6 and 92.6% of Li 7. The isotope Li 6,  
 which has an absorption cross-section of 945  
 barns to thermal and epithermal neutrons (i.e.  
 23000 times greater than that of Li 7), is  
 responsible for most of the damage undergone  
 by the crystals under the action of a neutron  
 flux. The reason for this is that the reaction  
 Li 6 ( $n, \alpha$ ) used for the production of tritium  
 also produces helium:



and the formation of bubbles of gas within  
 the lithium niobate or lithium tantalate crys-  
 tals, the resulting pressure increase, and then  
 the coalescence of these bubbles of gas result  
 in an increase in the internal stresses in these  
 crystals, which swell and finally burst, because  
 they are very fragile materials, and such  
 phenomena, of course, occur even more rapidly  
 as the instantaneous neutron flux increases.

In the specific case in which the lithium  
 niobate or lithium tantalate crystals are used  
 as piezoelectric materials for transducers, a  
 formation of tritium and helium bubbles in  
 this way and the swelling of the crystals are  
 responsible for a considerable reduction in the  
 qualities of such transducers (sensitivity, fre-  
 quency, resolving power and so on) and even  
 if crystal breakdown does not occur there is  
 a 30 db sensitivity loss for the following inte-  
 grated flux values:

$1.10^{13}$  nvt (thermal)

$1.25 \cdot 10^9$  nvt (fast)

The invention obviates the various disadvantages resulting from a neutron flux, by the use of Li 7-enriched lithium.

5 By way of example, if lithium formed by 99.99% of Li 7 is used for the formation of the crystals of lithium salts, the above-indicated damage produced by a neutron flux is reduced in a ratio of about 1000.

10 The materials according to the invention can operate at high temperature and are therefore very advantageous for use in nuclear reactors particularly for the following:

15 Ultrasonic testing: location of faults (cracks, corrosion, fatigue) of noise emitting sources;

The monitoring and measurement of levels, pressures, rates of flow, vibration etc.;

The production of strain gauges based on the piezoelectric or piezoresistive effect.

#### WHAT WE CLAIM IS:—

20 1. Piezoelectric materials of use as transducers in a neutron flux, characterised in that they are formed by crystals of lithium salts selected from the group comprising lithium niobate and lithium tantalate in which the lithium has a lithium 7 isotope content greater than that of natural lithium.

25 2. Materials according to Claim 1, characterised in that the lithium 7 isotope content is greater than 99%.

30 3. Piezoelectric materials substantially as hereinbefore described.

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